

Sept. 25, 1956

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2,764,360

APPARATUS FOR THE PRODUCTION OF FINELY DIVIDED MATERIALS

Filed March 3, 1953

3 Sheets-Sheet 1

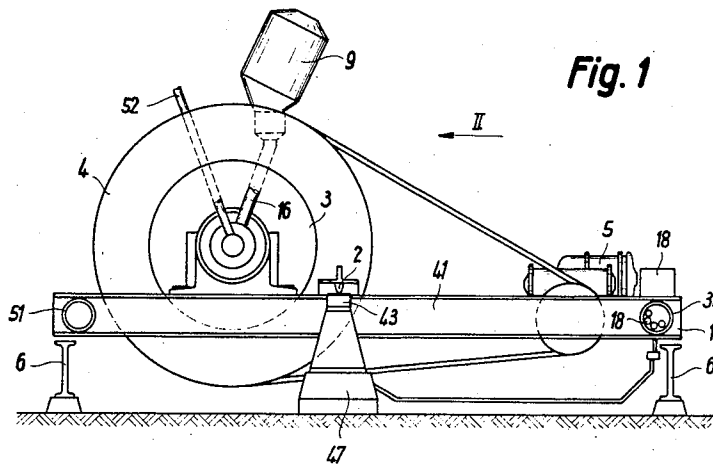


Fig. 1

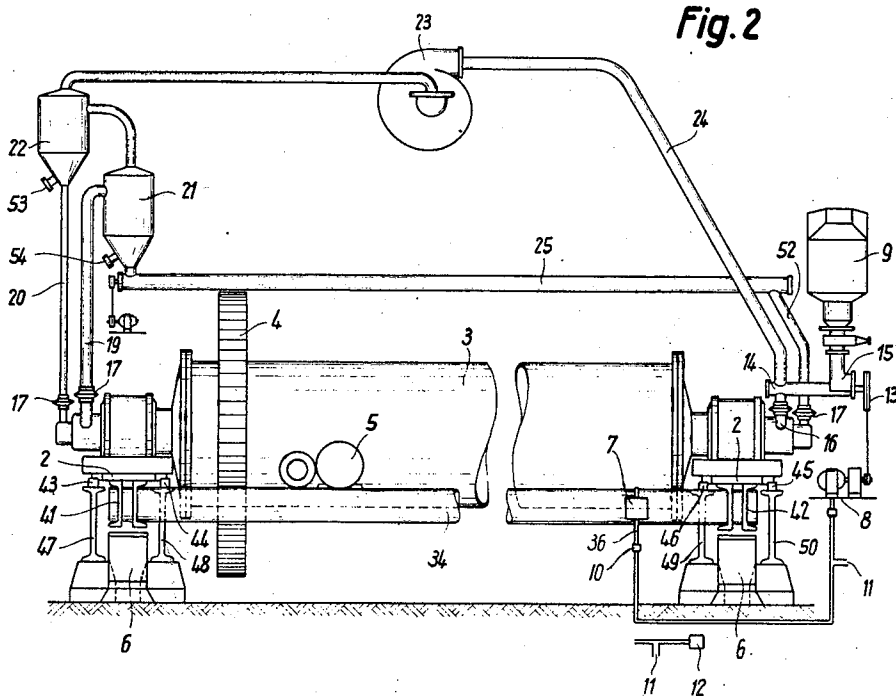


Fig. 2

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3 Sheets-Sheet 2

Fig. 3

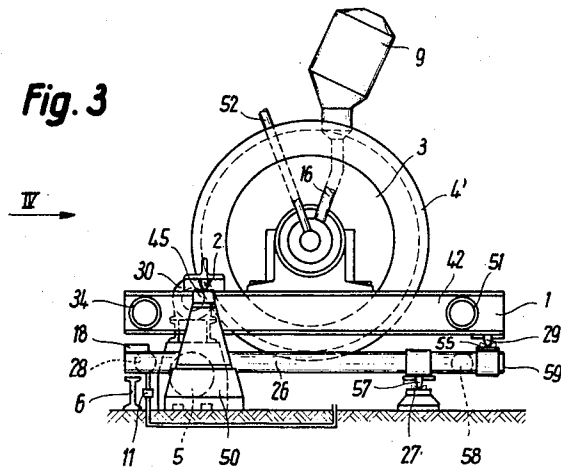
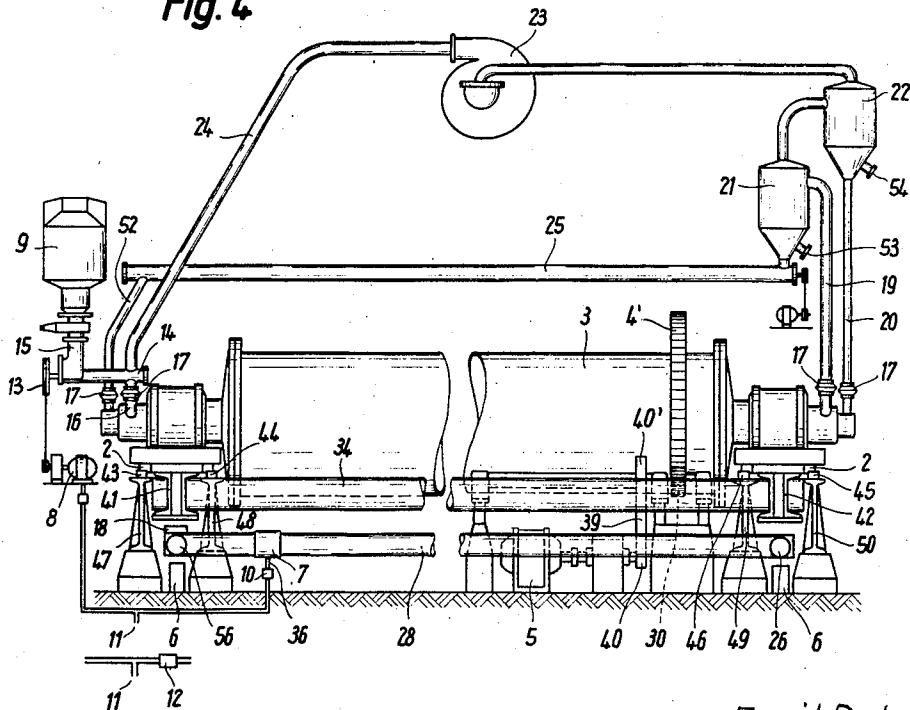


Fig. 4



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3 Sheets-Sheet 3

Fig. 5

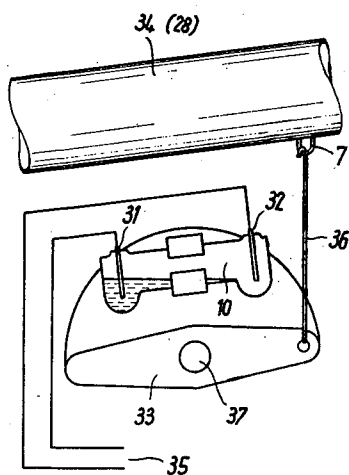


Fig. 6

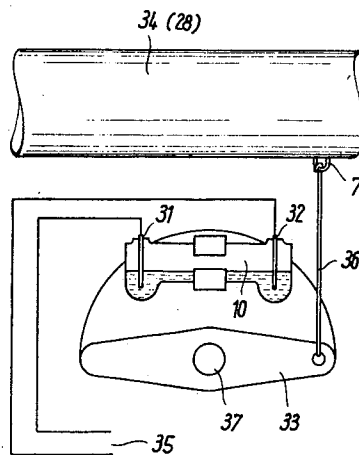
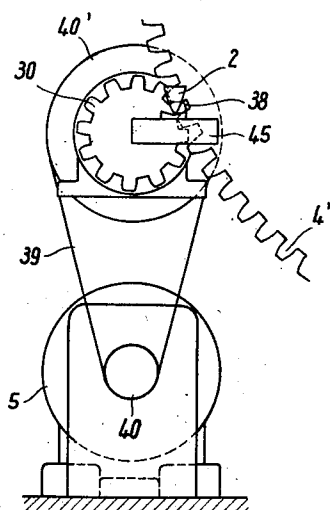


Fig. 7



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1

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APPARATUS FOR THE PRODUCTION OF FINELY DIVIDED MATERIALS

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15 Claims. (Cl. 241—34)

This invention relates to an improvement of a device for continuously producing extremely fine metal powders of laminar shape, and especially of uniform composition, form, and particle size. Such laminar metal powders are useful, for instance, in the manufacture of bronze and other metal pigments for use in lacquers and the like. The invention is directed more particularly to an auxiliary mechanism employed in such a device and adapted to continuously adjust the feeding of the entering material in relation to the discharge of the metal powder or the like.

Mills adapted to hammer and flatten granular metal and like powders by means of special flattening elements to a much greater fineness and thinness than was possible when using hammering or pounding methods have been known. In such mills a considerable number of flattening bodies were caused, mainly by means of lifting baffle plates within a rotating drum, to freely fall and, due to their free fall, to flatten and to convert the metal powder into a very thin high quality laminar material. Flattening mills of this type are described, for instance, by F. Skaupy in "Metallkeramik," 3rd edition, page 207, and in Revue d'Aluminium, 1934, pages 2739-2744. Such an improvement in fineness and quality of the resulting powder, however was obtained only when strictly observing appropriate conditions of operation and providing the required properly designed flattening mill. The conditions of operation depended upon various factors, such as the amount of the powder introduced into the mill and the number of flattening bodies used, i. e. of the ratio between the quantity of material to be flattened and the quantity of flattening bodies present. The size of the mill had to be in proper relationship to the number of flattening bodies and the amount of material to be flattened. These factors were determined by the desired fineness of the flattened powder. The amount of material to be flattened and the number of balls or other flattening bodies should preferably not be too large. It has proven of advantage to fill the flattening mill only to about one seventh of its total space. The material to be flattened is preferably present in such an amount that not too much thereof would be in the actual flattening zone between the flattening bodies. There must, however, be present enough of said material to avoid useless operation of the flattening bodies. In order to produce uniform results, the optimum ratio between size of flattening mill, number of flattening bodies, and amount of powder to be flattened must be maintained during the entire course of the flattening operation.

It was found that, when flattening, for instance, aluminum powder, optimum results are achieved by charging the mill only with so much of said powder that the hollow spaces between the flattening bodies are filled when the mill is at rest, and that, in addition, only a relatively thin layer of said aluminum powder covers the flattening bodies.

A flattening device as used for flattening, rolling, and polishing metal and the like powders to produce ex-

2

remely fine and thin leaflets of such powder differs considerably from grinding and milling devices, although they are apparently similar in their design. Flattening mills according to the present invention, cause merely stretching and smoothening of the powder particles, while with the known grinding and milling devices the powder particles are comminuted and ground to an obnoxious, highly reactive dust which results in blackening of the powder.

Other factors than those mentioned above are also of importance in order to achieve satisfactory and consistently reliable results. They involve steady discharging of the flattened powder at a uniform rate by means of a gas current and continuously keeping constant, not only the amount of material to be flattened but also its composition. Relatively slight deviations from such constant rate of feeding and discharging the metal and the like powder, of its composition and of other conditions of operation cause rapid deterioration of the quality of the metal powder. It is apparent that, when working intermittently, i. e. in batches, the composition of the material changes quickly.

Attempts have been made to interrupt the flattening procedure from time to time and each time to adjust the weights of mill and charge to their optimum value. They were, however, unsuccessful because intermittent charging of the mill caused disadvantageous variations in operation which had an unfavorable effect on the quality of the flattened material.

In the case of large grinding devices for grinding coarse material whereby insufficiently comminuted material is continuously removed from the grinding device by an air current and the coarser particles are continuously recirculated, attempts were made to avoid overloading of said grinding device by continuously adjusting the feed by means of and in accordance with the weight of the recirculated material. Such feed adjusting devices were rather complicated even when grinding coarse material. They failed completely when used in flattening mill for producing extremely thin and light metal powders for the pigment, lacquer and the like industry. Furthermore, these adjusting devices did not take into account variations in the charge. The amount of finished flattened material discharged from the mill and other factors play also an important role.

It is one object of this invention to provide a device adopted for the continuous production of flattened metal and the like powder of the finest quality and the highest uniformity.

Another object of this invention is to provide a device for automatically adjusting the feed in relation to the flattened powder discharged from the flattening mill so as to keep constant in the mill the amount of material to be flattened.

Other objects of this invention will become apparent from the specification and the explanations given herein-after.

These objects are attained in a simple and very effective manner by continuously supplying the material to be flattened by means of a feeding device which is controlled by the total weight of the mill, its contents included, in such a manner that the feeding slows down or is interrupted when the amount of material in the mill begins to exceed the prescribed optimum amount, and the feed is accelerated when the amount of material decreases below said optimum. Such a device has the further favorable effect that it compensates for variations in the material being supplied and in the flattening operation within the mill.

The feeding device preferably comprises a storage bin containing the material to be supplied, which is conveyed

3

from said bin to the flattening mill by a motor driven conveyor. The entire flattening mill with its contents and inlets and outlets for gas and material are mounted on a scale which is balanced at the prescribed optimum weight and which is sensitive to variations in weight that might occur during operation. In controls the feeding of the material during the flattening procedure.

For this purpose there is provided, for instance, at said scale a switch to close or open the circuit which drives the motor of the conveyor. The motor circuit is controlled either directly or by means of a relay, via the movable part of the scale, which actuates or stops the conveyor or causes it to run faster or slower, as required to provide uniformity of operation of the mill. To this end, a contact is provided on the lever arm of the scale preferably at or near the end thereof, whereby the motor circuit may be opened or closed or varied. As a result thereof, a very small travel of the lever arm is sufficient to control the flattening mill weighing many tons.

In order to secure smooth or vibrationless running of mill and conveyor, the center of gravity of the flattening mill must be displaced as little as possible during operation. For this purpose the rotating parts must be especially well balanced. Otherwise, as a result of displacement of the center of gravity, vibration of the device will result at each revolution, the intensity of which will depend upon the extent to which said displacement takes place. Therefore, the mill with its moving parts should be designed as symmetrically as possible including any required man-holes together with their covers. Any remaining unbalance may be eliminated by suitable counterweights, for instance, of iron.

As a preferred embodiment of this invention the device comprises a large scale or balance upon which the mill is mounted. An especially simple device of the highest degree of reliability in operation comprises a framework consisting of a pivoted tipping beam or lever on one arm of which, preferably the shorter one, the flattening mill is mounted. Balance is then effected by counterweights. The beam or lever may be provided with one or two arms. Of course, a design is preferred which requires the least number of knife edges or pivots. Supporting the beams or levers on knife edges is known for large scales as the most sensitive and also the most effective means of support, provided the knife edges are of high quality steel and rest on high quality bearings designed according to the load to be supported. It is, of course, also possible to use other kinds of bearings, such as ball bearings, roller bearings and the like.

When using large scales, not only the flattening mill but also the motor driving said mill may be placed thereon. In such case the motor is preferably arranged on top of or underneath the mill in order to keep the starting torque as small as possible. In the case of the pivoted lever, the mill is placed on the shorter arm thereof while the longer arm carries the motor. Thereby, said motor replaces part of the required counterweight.

The motor may also be mounted independently of the mill, provided that the movement of the scale is not substantially disturbed by the drive of the mill. Such disturbances have a slight effect only when, for instance, the driving shaft effecting transmission from the motor to the mill gear by means of chains, belts or the like, is arranged so remote from the axis of the mill and as vertical as possible to the direction of motion, that by the rotation of said driving shaft no detrimental change in distance will occur. For this purpose a rather long connection is required. It is, however, simpler especially in the case of transmission by means of gears or belts, to arrange the driving shaft in such a manner that the point of application of the driving gear on the gear or pulley of the mill lies in line with the axis of rotation of the scale so that even if said scale moves, no change in the distance between the axis of the mill and driving shaft can occur.

4

The movement of the scale is dependent upon the following requirements. It must be sufficient to close or open respectively the contact of the switch in the circuit of the drive motor and to operate the adjusting device which controls operation of the conveyor and its motor.

Since the general construction and many of the details in flattening mills and feeding devices are well known and are familiar to those skilled in the art and since these mills are rather large and elaborate structures, it is only necessary for an understanding of this invention to illustrate and describe so much of such mills and feeding devices as will disclose the present invention. It will be understood also that in this disclosure many details of construction, such as supports and mountings of the various shafts, gearing, specific means of adjustment etc. are omitted as unnecessary and as interfering with a consideration of the embodiment of the invention and will be readily supplied by those skilled in the art.

The embodiments as illustrated by the following drawings are indicative of but a few of the various ways in which the principle of the invention may be employed.

Fig. 1 is an end elevational view of a flattening mill with its feeding device and drive motor arranged on a pivoted lever balancing frame as seen from the discharge end;

Fig. 2 is a front elevational view of the device shown in Fig. 1;

Fig. 3 is an end elevational view of a flattening mill with its feeding device arranged on a double balancing frame, wherein the drive motor is mounted separate from and underneath of said mill;

Fig. 4 is a front elevational view of the device shown in Fig. 3;

Fig. 5 is an enlarged detailed view, somewhat diagrammatic, illustrating a mercury switch in the position wherein the circuit and the feeding of the mill is interrupted;

Fig. 6 shows the same mercury switch in the closed position wherein the circuit is closed and material is supplied to the mill, and

Fig. 7 is a diagrammatic view showing the transmission of power from the separately mounted motor of Figs. 3 and 4 to the gear of the flattening mill, so that the rotation of said motor does not substantially affect the balancing device.

In Figs. 1 and 2 the beam frame 1 consists of two levers 41 and 42 which are firmly connected with each other by means of tubular connecting beams 34 and 51 so as to form a strong frame, usually of steel members of sufficient strength to support the flattening mill, feeding device, and drive motor. Said frame is provided with knife edges 2 on each of the levers 41 and 42 made of hardened steel, such as used for large-sized scales. Said edges 2 rest on bearing plates 43 and 44, and 45 and 46, respectively, which are supported by standards 47 and 48, and 49 and 50, respectively. Said edges are dimensioned according to the total load they have to support.

Frame 1 provides a short lever arm and a long lever arm. Flattening mill 3 is placed on the short lever arm and is provided with pulley 4 which is engaged by a chain or belt or other transmission means so that said pulley 4 and flattening mill 3 are rotated by drive motor 5. Motor 5 is placed on the longer lever arm of frame 1 and it serves as a counterweight for flattening mill 3 on balancing frame 1. At both ends of the lever arms and spaced therefrom at a distance of a few centimeters are abutments 6 which limit the travel of said frame 1. Said travel is limited and sufficient only to permit opening and closing of the circuit with certainty.

At point 7 rod 36 is affixed to connecting beam 34 of the longer lever arm of frame 1 and to switch 10, which may be a mercury switch. Such movement causes opening of the switch and interruption of the circuit when the longer arm of balancing frame 1 moves in upward direction as a result of an overload of the flattening mill 3, and closing of the switch when said longer arm of frame

5

1 moves in downward direction as a result of insufficient charging of mill 3. Said switch 10 opens and closes the circuit of driving motor 8 which actuates the material feed from container 9. Switch 10 which is illustrated more in detail in Figs. 5 and 6, is fed, for instance, from the power source 11.

Should a still more sensitive switch be required it is advisable to insert relay 12 in the circuit of switch 10 by means of a second circuit which in turn will then open or close the circuit of motor 8 which drives screw conveyor 14 by means of pulley 13. The material to be flattened passes from storage tank 9 through tube 15 and conveyor 14 and is conducted through tube 16 into mill 3 as long as motor 8 runs. Plain leather, rubber or the like flexible sleeves 17 connect the movable tubes of the mill with the stationary elements of said conveyor. Said sleeves need only be very short because the movement of the mill, in case an adequate transmission ratio is provided, requires hardly more than a travel of 1 mm.

The whole flattening device may be filled with inert gases, especially when arranging for a recirculation of the gas. To this end, the gas is conducted into mill 3 by means of independently mounted blower 23 through the tubes 24 and 16. The gas carries the flattened product through outlet pipe 19 into the first separator 21. The material which has not been sufficiently flattened is returned from said separator 21 through screw conveyor 25 and pipe 52 into the mill. The gas carries the sufficiently flattened material from separator 21 to a second separator 22 to cause further separation into coarser and finer particles. The coarser, insufficiently flattened material is returned to mill 3 by means of return-pipe 20. Pipes 19, 20, and 52 are also provided with leather, rubber and the like flexible sleeves 17 to assure proper connection of said stationary parts with the movable outlet and inlet elements, respectively, of mill 3. When flattening material which is not sensitive to air, blower 23 may circulate air. In this case it is not necessary to recirculate the material to be flattened but it may be discharged by separating it from the air current and discharging the flattened material by suction from mill 3.

The weight of flattening mill 3 and its contents is balanced by means of suitable counterweights 18 arranged, for instance, within tubular connecting beam 34 and at least part of said counterweights 18 may consist of scrap iron. Discharge openings 53 and 54 are provided in separators 21 and 22 for removal of the finished flattened material.

Figs. 3 and 4 illustrate a modified form of balancing device 1 for flattening mill 3, which requires less space and has a higher ratio of transmission than the device of Figs. 1 and 2. Its drive motor 5 is placed underneath the device and is firmly secured to the base. The lever arm of the balancing device is also constructed as a frame, by connecting two rigid beams 41 and 42 with tubular connecting beams 34 and 51. Said lever frame 1 is provided near its one end with knife edges 2 which rest on bearing plates 43 and 44, and 45 and 46 respectively, which are supported by fixed standards 47 and 48, and 49 and 50, respectively. Mill 3 with gear 4' is placed as closely as possible to said edges 2 and is driven by motor 5. Transmission of power from said motor 5 to said gear 4' is effected by means of pulley 40, belt 39, and pulley 40' rotated by gear 30 which is mounted independently from balancing frame 1 and on a stationary support.

The point of engagement of gear 30 with gear 4' is in alinement with the points of contact of knife edges 2 on plates 43 and 44, and 45 and 46 respectively. At the opposite end of balancing frame 1 there are arranged, at the lower face of beams 41 and 42, two further knife edges 29 which rest upon bearing plates 55 provided on the upper face of a pair of tubular lever beams 26 and 56 which, together with tubular beams 28 and 58 connecting the same, constitute a second frame 59 arranged underneath balancing frame 1. Said second frame 59 con-

6

stitutes a lever which is pivoted by means of two knife edges 57 on bearing plates 27 on beams 26 and 56. At point 7, for instance, a rod 36 is secured to said tubular connecting beam 28 of the longer lever arm of second frame 59 in such a manner that it actuates one arm of a mercury switch 10. The other elements, power connection 11, relay 12, and driving motor 8, are arranged in the same manner as described with regard to Figs. 1 and 2. The feeding device with driving gear 13, screw conveyor 14, storage tank 9 as well as the separators 21 and 22 with devices for recirculating insufficiently flattened material with blower 23, tubes 24, 16, 19, 20 and 52, screw conveyor 25, sleeves 17 and discharge openings 53 and 54 are also the same as illustrated in Figs. 1 and 2. Counterweights 18 are provided at the end of the longer lever arm of frame 59 and stops 6 serve to limit the travel of said frame 59.

Figs. 5 and 6 show in detail a suitable switch 10 for closing and opening the circuit in accordance with the downward or upward movements, respectively, of connecting beams 34 of (Figs. 1 and 2) or 28 of (Figs. 3 and 4). A mercury switch is preferably used since such a switch is capable of operation for a very great number of circuit closings and openings. Rod 36 is fastened by a hinge 7 to said connecting beams 34 and 28, respectively. The opposite end of said rod is pivotally connected to the one end of lever 33 pivoted on pin 37, the mercury switch 10 being mounted on lever 33. The two electrodes 31 and 32 of said switch 10 are connected by conductors 35 to power source 11, or relay 12 and power source 11, respectively, and to motor 8 actuating conveyor 14.

Fig. 5 shows a position wherein connecting beam 34 is moved upwardly by an overload in flattening mill 3, i. e. when more than the required amount of material to be flattened is supplied to the mill. In this case, the circuit is opened and feeding ceases. Fig. 6 illustrates the position wherein connecting beam 34 is lowered due to insufficient charging of the mill. Thereby the circuit is closed and the feeding device 14 is actuated, thus, charging the mill until it is slightly overcharged so that said overload causes upward movement of beam 34 and, consequently, opening of the circuit. This actuating and arresting of the feeding device is repeated continually with only slight variations in the amount of material to be flattened present in mill 3 and, thereby, assuring the maintenance of uniform conditions in said mill.

Fig. 7 indicates in greater detail the position of driving gear 30 to gear 4' of mill 3 as shown in Figs. 3 and 4. This preferred mode of power transmission from motor 8 to mill 3 practically eliminates any substantial influence of said power transmission upon the movement of the balancing device. The point of contact of knife edges 2 and the point of engagement 38 of the teeth of gear 30 with the teeth of gear 4' are in alinement. Driving gear 30 is driven either by belt and pulley arrangement 40—39—40' or directly from the shaft of motor 5.

In these embodiments of the present invention devices have been described which permit continual adjustment with a sufficient degree of accuracy of the rate at which the material to be flattened is to be supplied to the mill depending upon the rate of discharge of flattened material. Ordinarily interruption of the automatic supply of material to be flattened to the mill can be accomplished without the intermediate relay. It is, of course, also possible to provide such a relay whereby less electric current is consumed and which is more sensitive in operation.

Another way of continually adjusting and controlling the rate of feed consists in providing suitable drive motors which are connected or disconnected by the action of suitable resistances. This way, however, is more complicated than the above described one.

The device according to this invention is of special value in the manufacture of bronze or other metallized paints, pigments and the like wherein it is of the utmost importance to always work under the same uniform con-

ditions. This device, however, has also proven of great advantage in the manufacture of extremely fine powders of always uniform composition, even of material which does not form leaflets and which is non-metallic. This is, as is well known, especially difficult when the particle size must be within very small limits, especially when said particle size is so small that separation by sieving is not possible. The necessity of separating such powders in suitable separators, the proper and accurate performance of which depends basically upon the amount of powder supplied to such separators and upon its composition, requires a steady and uniform supply of said powder from the mill to said separators.

Powders as they are obtained by means of a device according to this invention, are used with great advantage for magnetic purposes, in electric communication equipment, as fillers, paints, pigments, for ceramic mixtures, and other uses.

I claim:

1. Apparatus for the production of finely divided materials, particularly of plate-like metal powders which comprises a base, a rotatable mill, a rigid frame, said mill being mounted on said frame, said frame being pivoted on said base for tilting movement, said mill being on one side of said pivot and a counterweight on the other side thereof, means for feeding material to and means for discharging material from said mill including a feed motor, a switch connected to said motor, an operating member connected to said switch and to said frame, whereby in place of outgoing material corresponding quantities of material are introduced into the mill, whereby the mass of the material in said mill remains substantially constant.

2. Apparatus according to claim 1 in which a driving motor for said mill constitutes at least part of said counterweight.

3. Apparatus according to claim 1 in which said pivoted frame has a longer and a shorter arm, said mill being mounted on said shorter arm.

4. Apparatus according to claim 1 in which said switch is a tilting-type mercury switch mounted separately from said frame.

5. Apparatus according to claim 1 in which said frame is rectangular with a pair of said pivots in alinement and on opposite members of said frame.

6. Apparatus according to claim 1 in which a driving motor for said mill is mounted on said base and a power transmission connection is provided between said motor and mill.

7. Apparatus according to claim 6 in which a gear on said mill meshes with a gear operated by said motor.

8. Apparatus according to claim 6 in which a gear on said mill meshes with a gear operated by said motor, the point of meeting of said gears being in alinement with said pivots.

9. Apparatus for the production of finely divided materials, particularly of plate-like metal powders which comprises a base, a rotatable mill, a first rigid frame, said mill being mounted on said frame, a second rigid frame, said first frame being pivoted on said second frame, said

second frame being pivoted on said base for tilting movement, the counterweight being so positioned on the said lower frame as to balance the said mill, means for feeding material to and means for discharging material from said mill including a feed motor, a switch connected to said motor, an operating member connected to said switch and to said second frame, whereby in place of outgoing material corresponding quantities of material are introduced into the mill, whereby the mass of material in said mill remains substantially constant.

10. Apparatus according to claim 9 in which said first frame is pivoted onto said second frame at one end thereof.

11. Apparatus according to claim 9 in which said second frame has a longer and a shorter arm, the pivot between said first and second frames being on said short arm.

12. Apparatus according to claim 11 in which the counterweight is on the said longer arm.

13. Apparatus for continuously producing powders of fine particle size and uniform composition, especially of fine laminar metal powders useful for bronze and the like pigments by means of flattening mills provided with means for discharging the flattened material by means of a gas stream, said device comprising a base, a frame thereon, alined pivots for said frame and on which said frame is balanced, a mill rotatably mounted in said frame, means for feeding material to and discharging it from said mill mounted on said base and independently of said mill and frame, variable feeding means for said material, said frame adapted to tilt on said pivots when said mill contains substantially different quantities of material, a device actuated by said tilting and connected with said feeding means adapted to change the rate of feed of said material to compensate for said discharge and to restore said frame to balance, whereby the mass of material in said mill remains substantially constant.

14. Apparatus according to claim 13, wherein there is present means continuously regulating feeding of the mill adapted to interrupt feeding of the mill as soon and as long as the optimum quantity of material in said mill is exceeded, and to actuate the feeding means as soon and as long as less than the optimum amount of material is present in said mill.

15. Apparatus according to claim 13 wherein there is provided a contact attached to the movable parts of said balancing element, said contact actuating the said device.

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